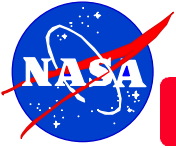


Section 7

LEISA Atmospheric Corrector (LAC)

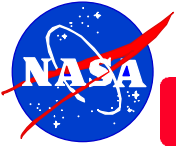
... Dennis Reuter

EO-1 LEISA Atmospheric Corrector



Requirements

- ◆ *Correct High Spatial Resolution Multispectral Imager Data for Atmospheric Effects*
- ◆ *Hyperspectral Imager*
- ◆ *Moderate Spectral Resolution (<10 nm)*
- ◆ *Moderate Spatial Resolution (<300 meter)*
- ◆ *Minimize Impact on Spacecraft Resources*
- ◆ *Maximize Flexibility*

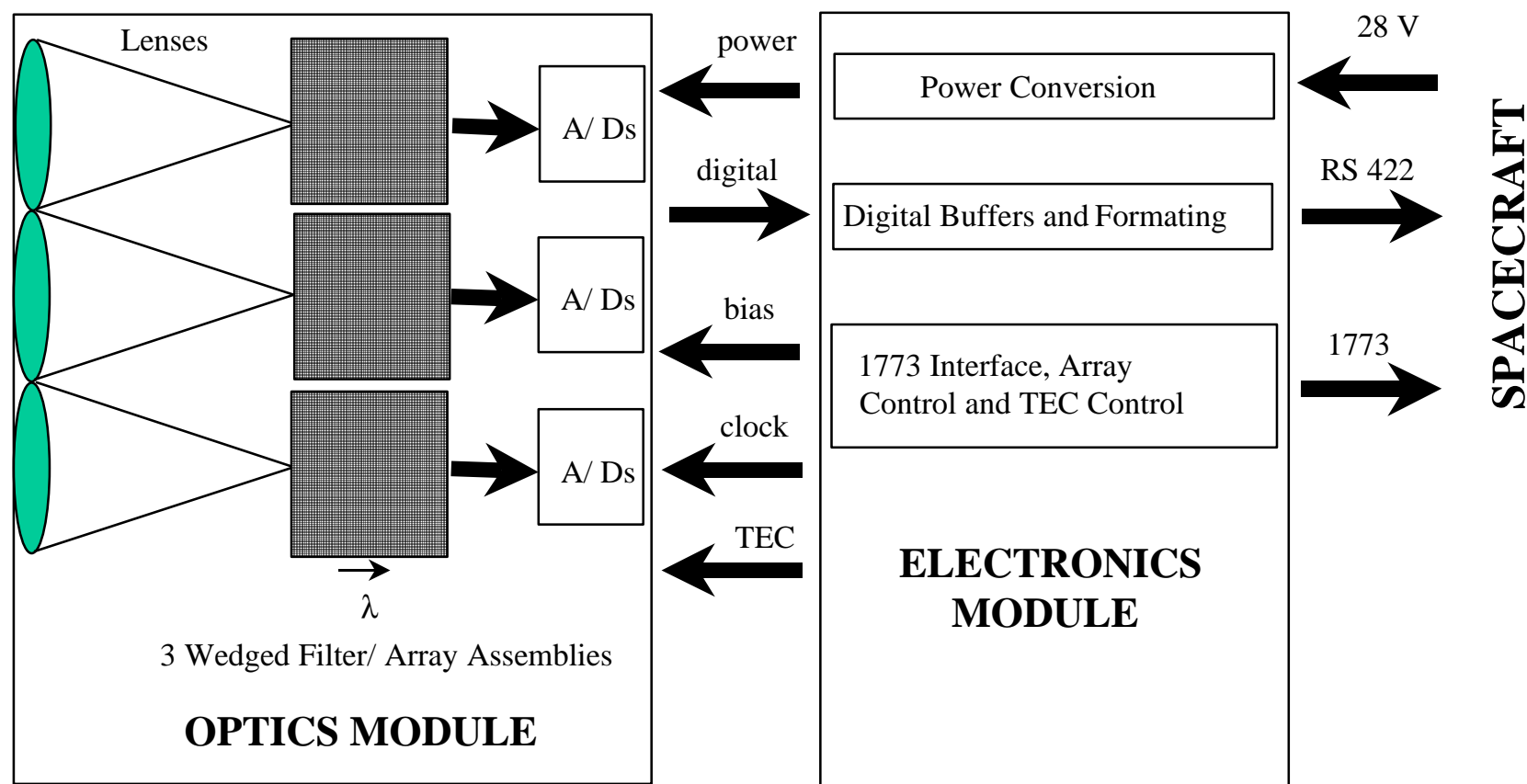


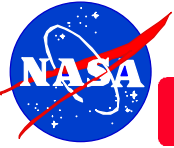
Contribution to EO-1

- ◆ *Validation of Wedged Filter Approach for Spacecraft Instrumentation*
- ◆ *Atmospheric Correction for ALI Multispectral Images.*
- ◆ *Atmospheric Correction for Landsat-7 Images (Formation Flying).*
- ◆ *Direct Study of Spatial Resolution Degradation (Cross-Comparison with Hyperion).*
- ◆ *Retrieved Atmospheric Parameters.*
- ◆ *Cross-Comparisons with MODIS.*

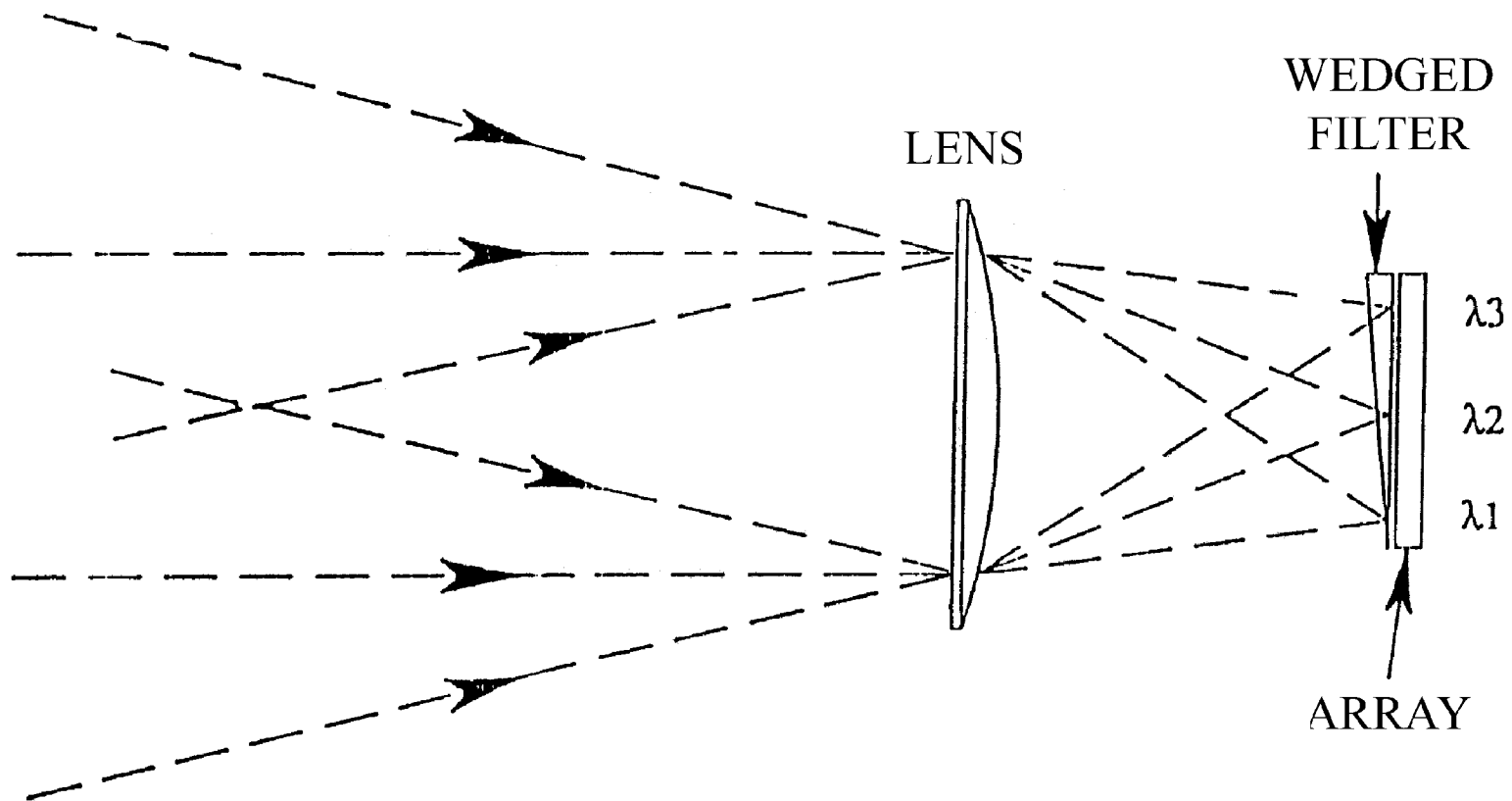


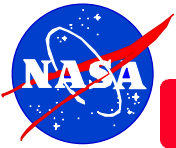
LAC Block Diagram



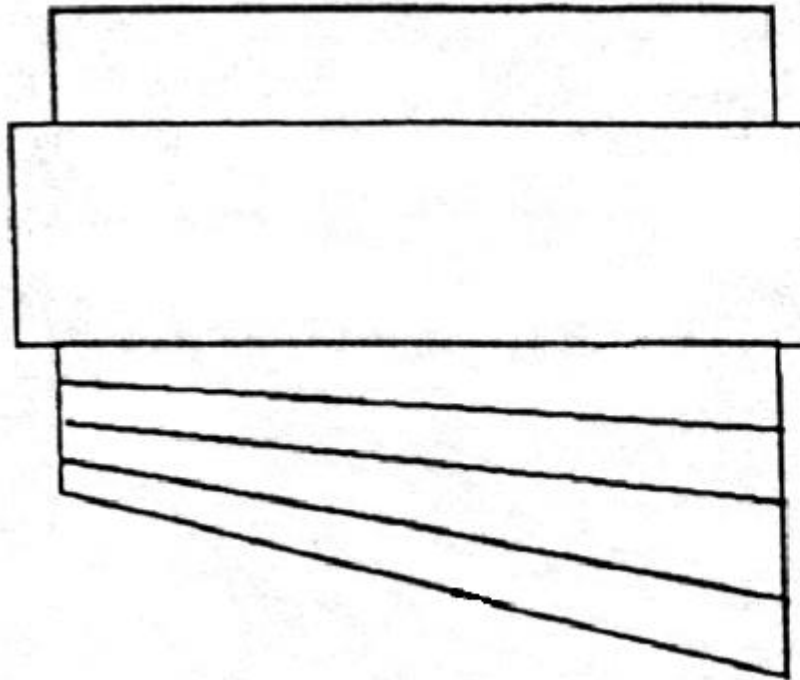


Wedged Filter Operation





Wedged Filter Schematic



Wideband Attenuation

Substrate

Longwave pass

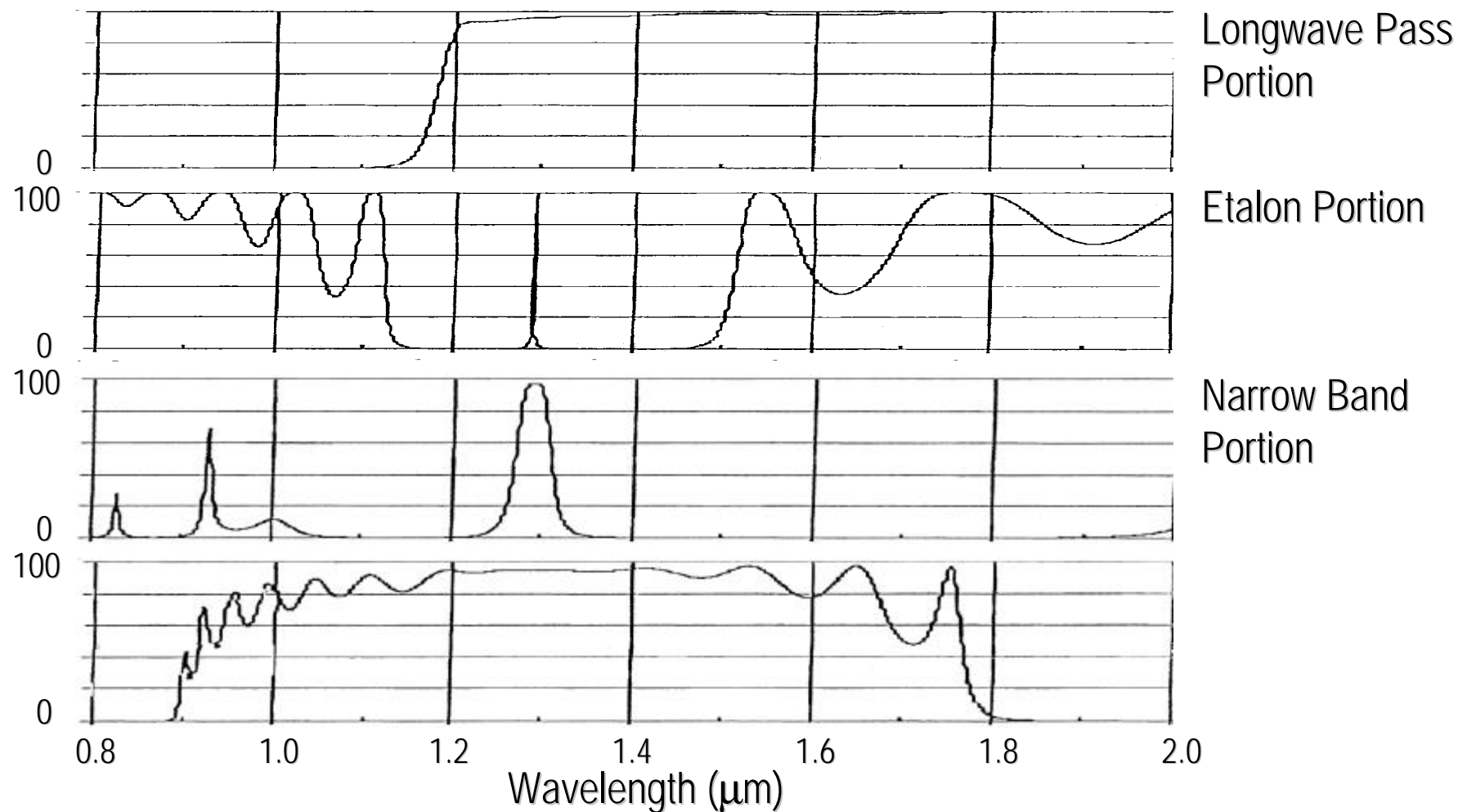
Etalon

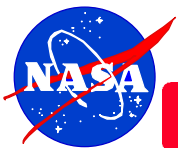
Narrow bandpass

Shortwave pass

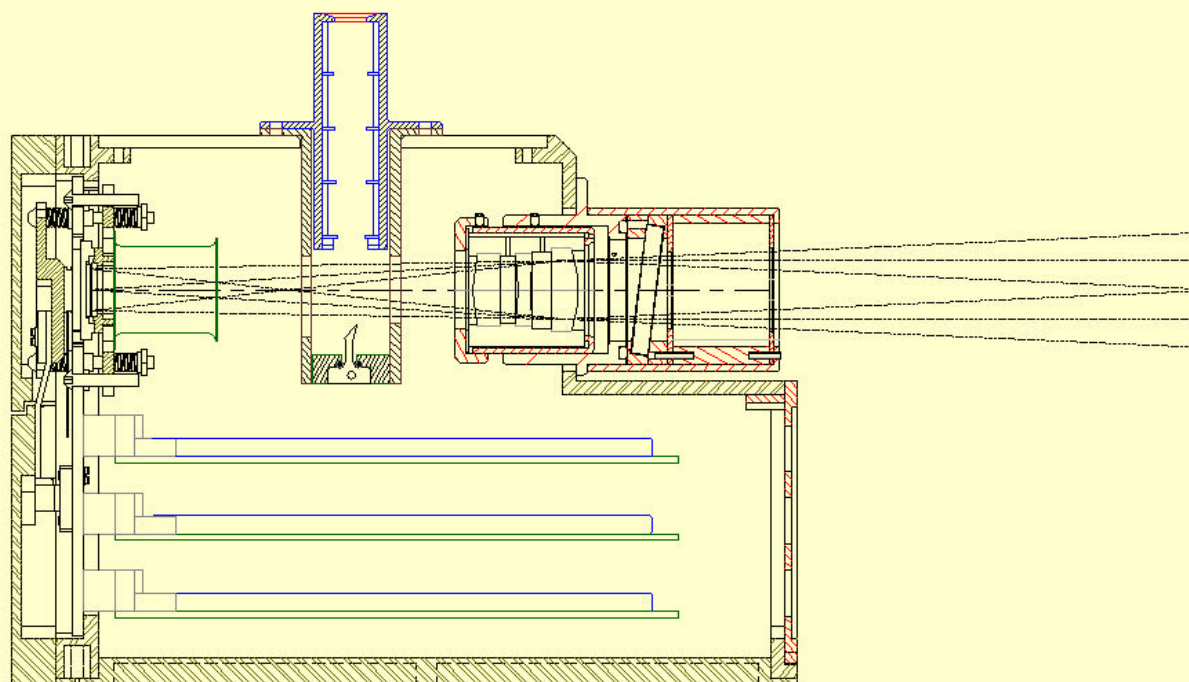


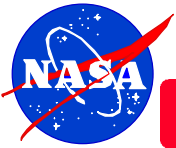
Filter Layer Composite Detail



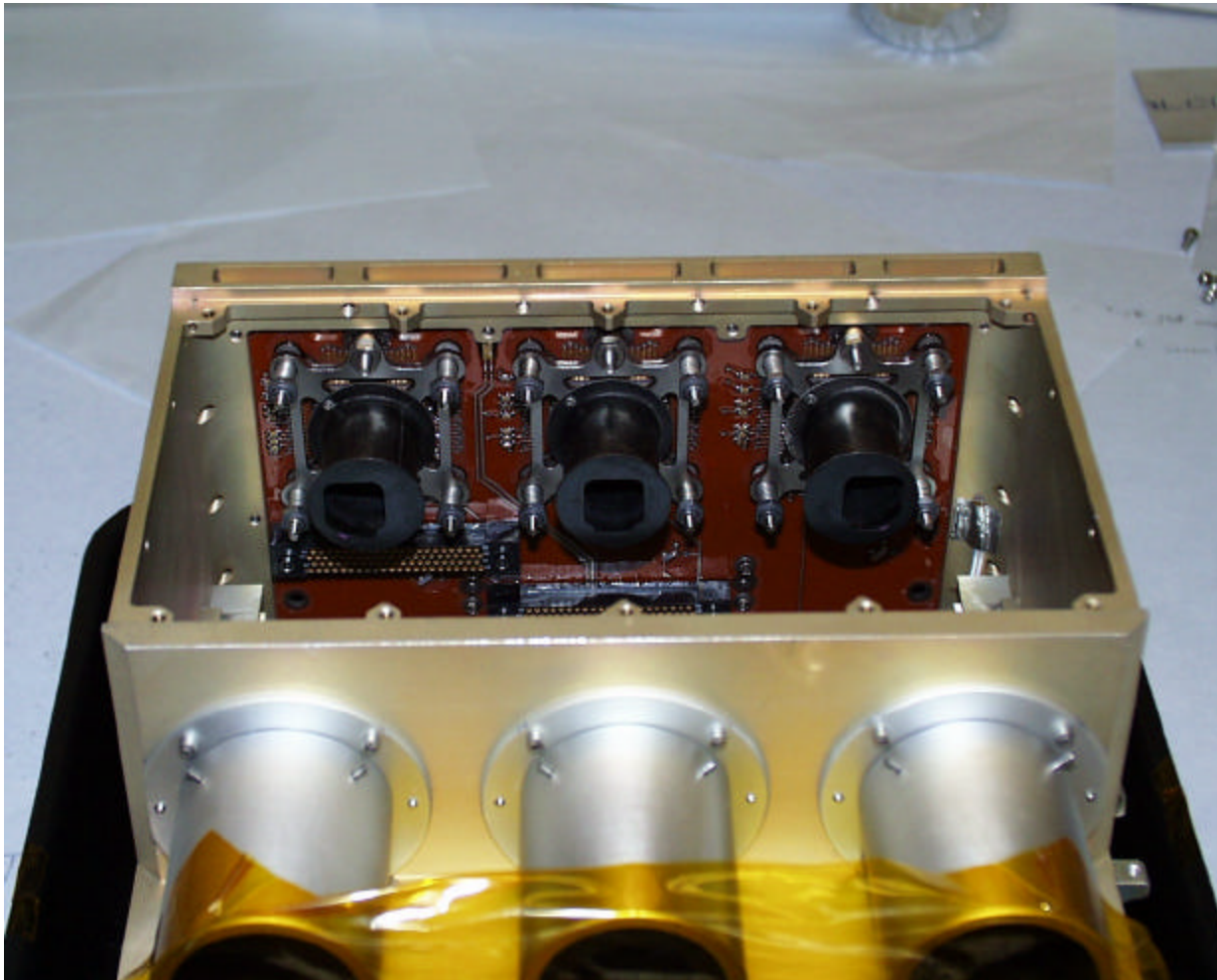


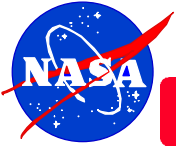
Optics Module Detail





LAC Internal Detail



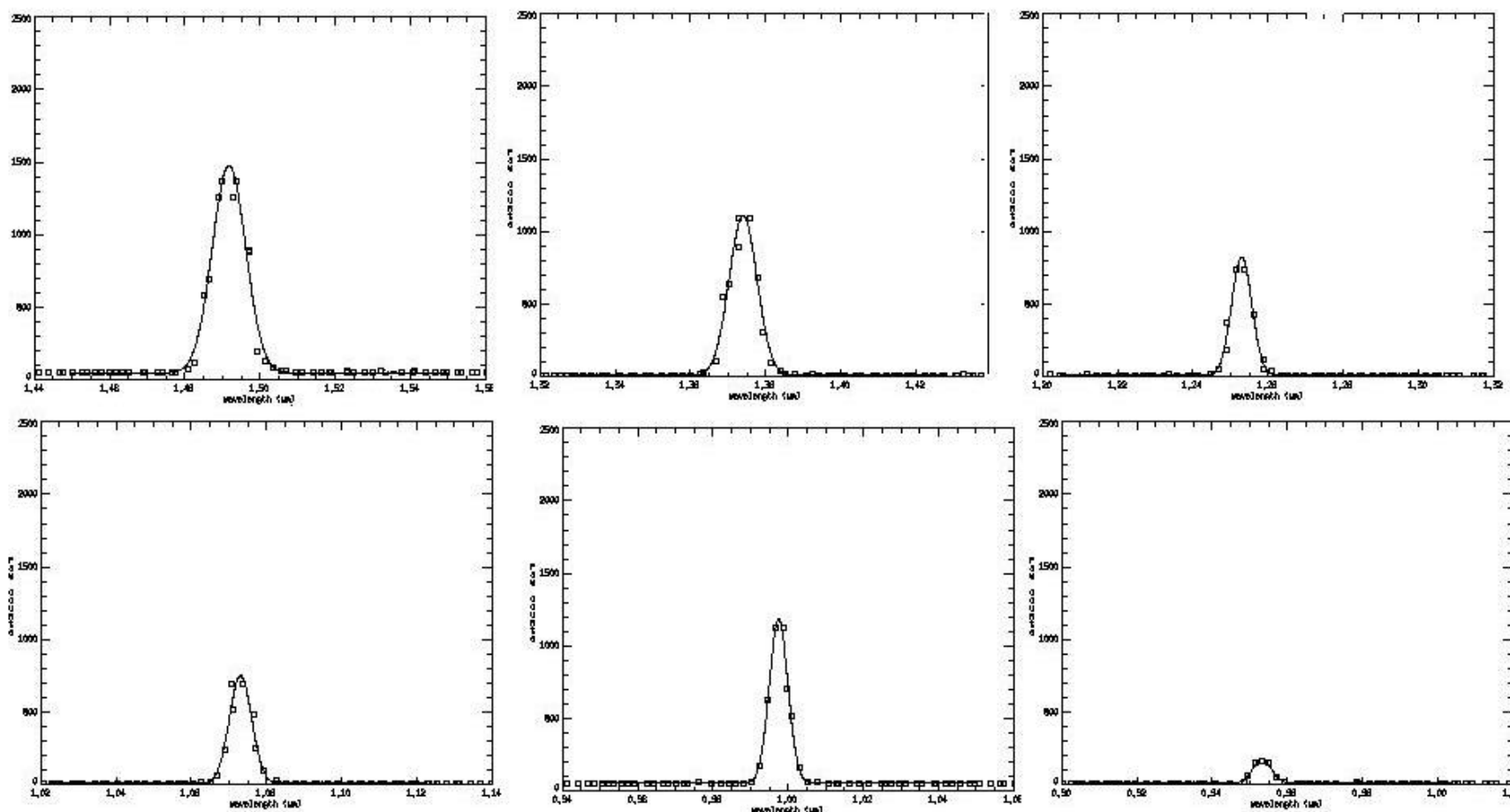


LAC Performance

- ◆ ***Spectral Coverage: ~0.9 - 1.6 μm ; 256 Bands Selected for Optimal Correction of High Spatial Resolution Images.***
- ◆ ***Spectral Resolution 2 Filter Sections:***
Section 1 ~35 cm^{-1} (DL : 5 nm @ 1.2 μm , 9 nm @ 1.6 μm)
Section 2 ~55 cm^{-1} (DL : 4 nm @ 0.9 μm , 8 nm @ 1.2 μm)
- ◆ ***Swath Width: ~185 km; Matches Landsat***
- ◆ ***Spatial Resolution (pixel): 356 mradian (250 meter @ 705 Km).***
- ◆ ***Three 256 x 256 Element InGaAs Arrays; TEC Stabilized (<285 K).***
- ◆ ***Three 15 Degree FOV 3 Element Lenses***
- ◆ ***Two Modules: "Bolt-on" Optics Module and Electronics Module.***
- ◆ ***Mass: 10.5 kg (EM, 4.4 kg; OM 3.9 kg; Cable 2.2 kg)***
- ◆ ***Power: 48 W (Peak); <15 W (Orbital Average)***

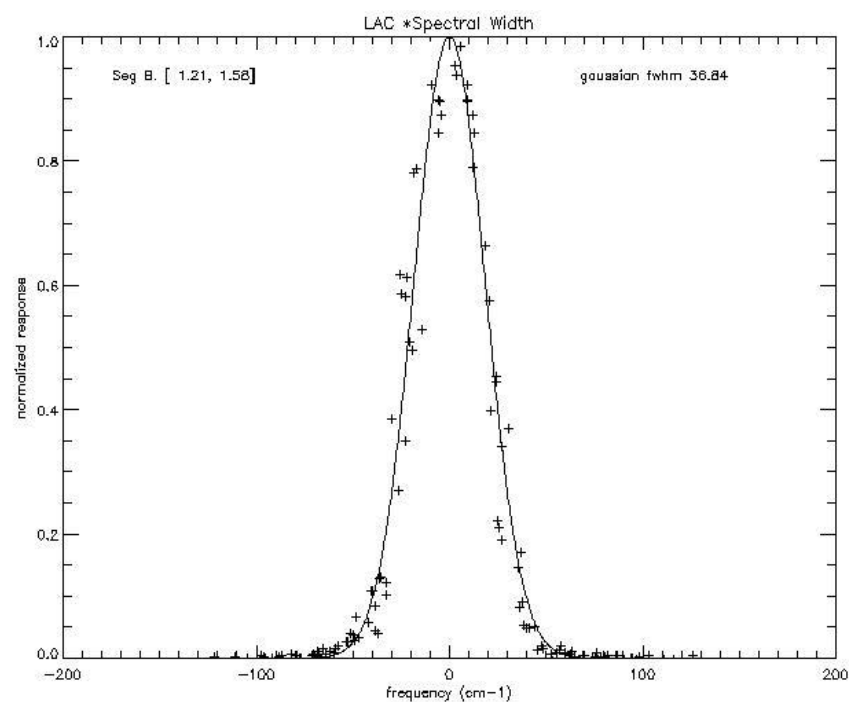
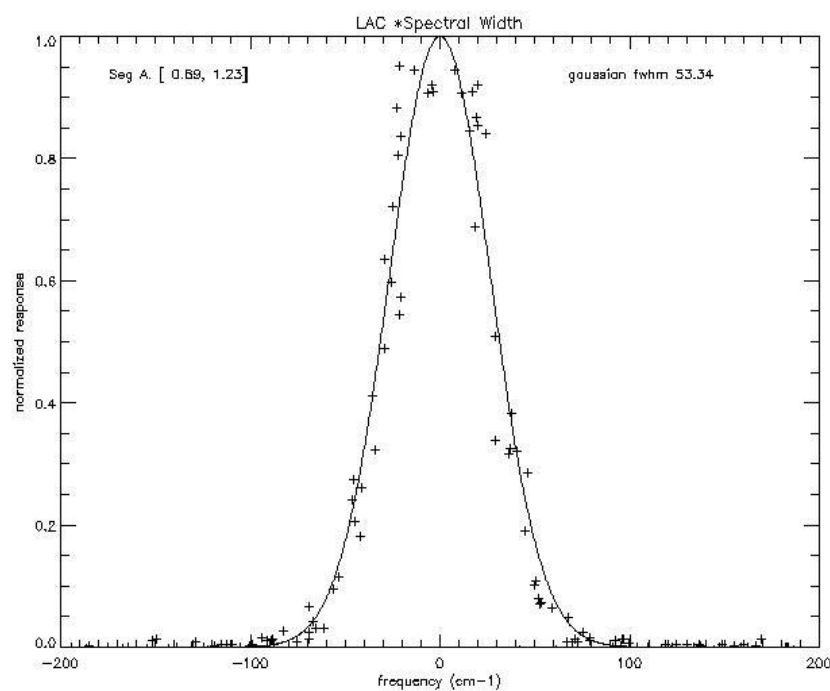


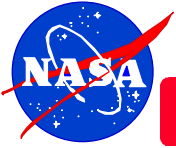
LAC Line Widths





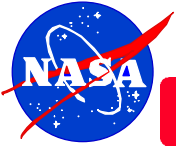
LAC Half-Width Summary





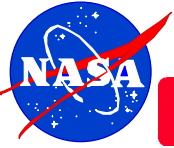
LAC System Trades

- ◆ ***Spatial Resolution vs. Spatial Coverage***
 - *250 meter spatial resolution near maximum required for atmospheric correction*
 - *185 km Matches Landsat7*
 - *Requires three 256 x 256 arrays*
- ◆ ***Thermo-Electric Coolers (TEC) vs. Passive Radiators***
 - *TECs require more power, but significantly simplify integration and operations*
- ◆ ***Wedged Filter vs. Conventional Technologies***
 - *Wedged filter data Analysis systems not as developed but instrument has less mass and complexity than conventional*
 - *No moving parts*



LAC System Trades

- ◆ ***IR vs. Visible Spectral Coverage***
 - *IR gives better water vapor and cirrus cloud information at the expense of aerosol information*
 - *InGaAs arrays now can cover 0.5 to 1.7 micron*
- ◆ ***1.6 vs. 2.5 micron Longwave Cutoff***
 - *Cryogenic cooling not required*
- ◆ ***Two Module vs. 1 Module Design***
 - *Gain in system flexibility and platform independence compensates for increased mass and additional integration*



LAC Performance Testing

◆ **Box Level**

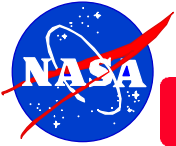
- *All Cards Simulated on an Individual Basis*
- *TECs Tested with Engineering Backplane (Focal Plane)*
- *Focal Plane Timing Tested with Multiplexers*

◆ **Subsystem Level**

- *OM: Limited Set of Images Obtained with EM Simulator*
 - *Engineering Model Vibration Tested*
- *EM: Operation Tested by Interface to OM Simulator*

◆ **Instrument Level**

- *Vibration and Thermal-Vacuum*
- *Radiometric/ Spectral Calibration and Alignment*
- *EMI/EMC*



LAC Test Descriptions

◆ **Vibration:**

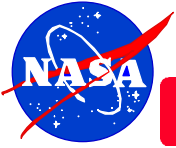
- *Individual Modules Tested to Proto-flight Level (1.25 X Expected Maximum Flight Loads)*
- *Instrument Mounted on Spacecraft and Tested to Flight Level*

◆ **Thermal Vacuum (Pre-spacecraft Integration):**

- *Four Cycles to Survival Levels (-10° C to + 50° C; Range Expected on Orbit 20° C ± 10° C)*
- *Operation from 0° C to 30° C (Orbital Predict 20° C, 30° C Worst Case)*
- *Images Obtained Using LAC GSE*

◆ **Thermal Vacuum (Integrated with Spacecraft):**

- *Four Cycles*
- *Operation from 0° C to 30° C (No Operation at 40° C)*
- *Images Using Spacecraft System (WARP, XPAA, etc.)*



LAC Test Descriptions

◆ **EMI/EMC:**

- *Instrument Level Tests: Conducted and Radiated Emissions, and Radiated Susceptibility*

◆ **Alignment:**

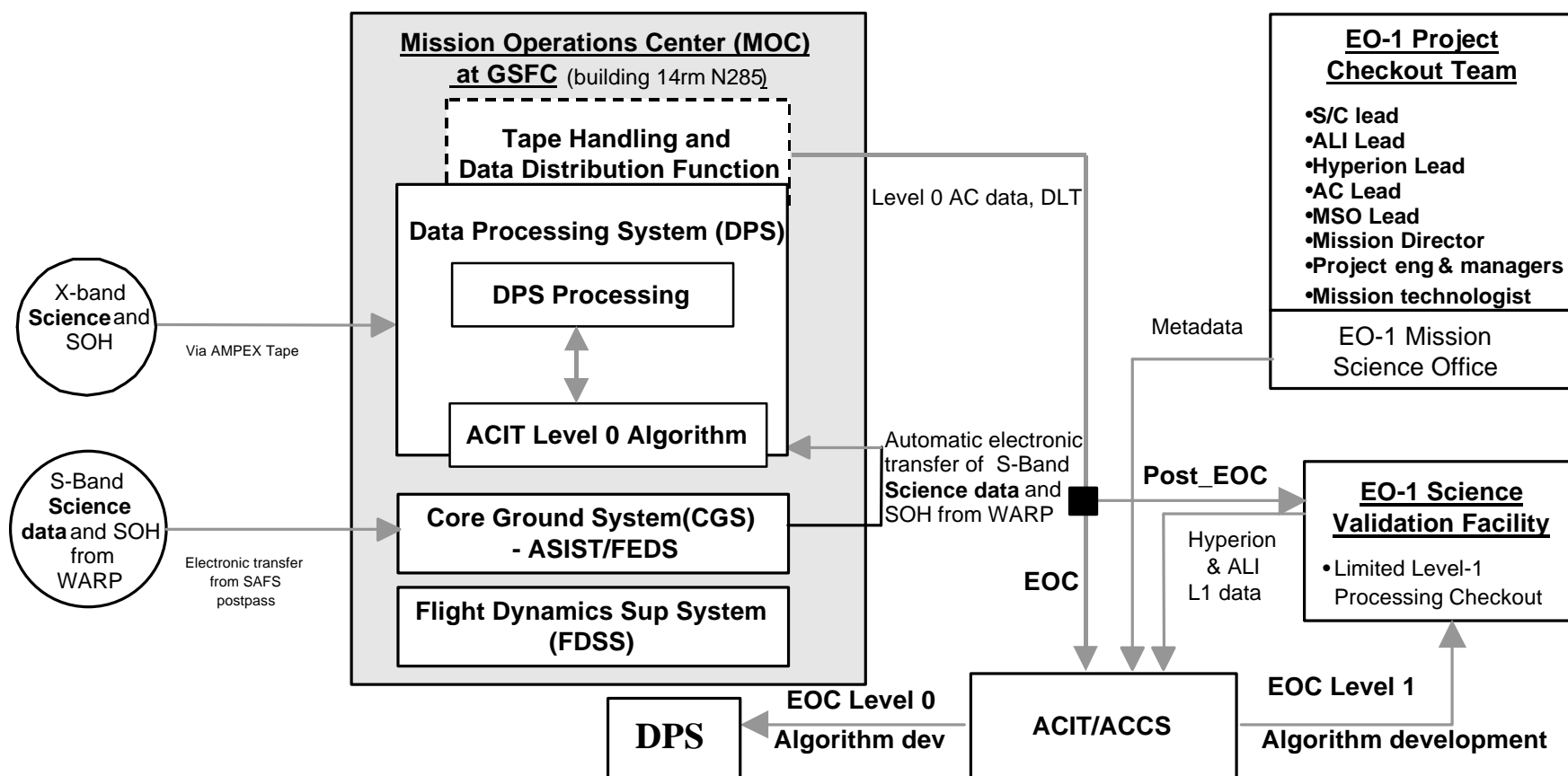
- *Orientation of Arrays with respect to Alignment Cube Using Theodolites*
- *LAC Alignment to ALI on Spacecraft Using Theodolites*

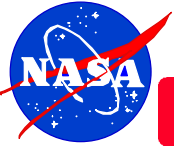
◆ **Optical Calibration:**

- *Wavelength and Instrumental Shape: Grating Monochrometer 1 to 100 nm Steps*
- *Radiometric: Calibrated Black-body (all 4 TEC Settings)*
- *Flat Field: Diffuse Source Illuminating Lenses and Solar Calibrators*

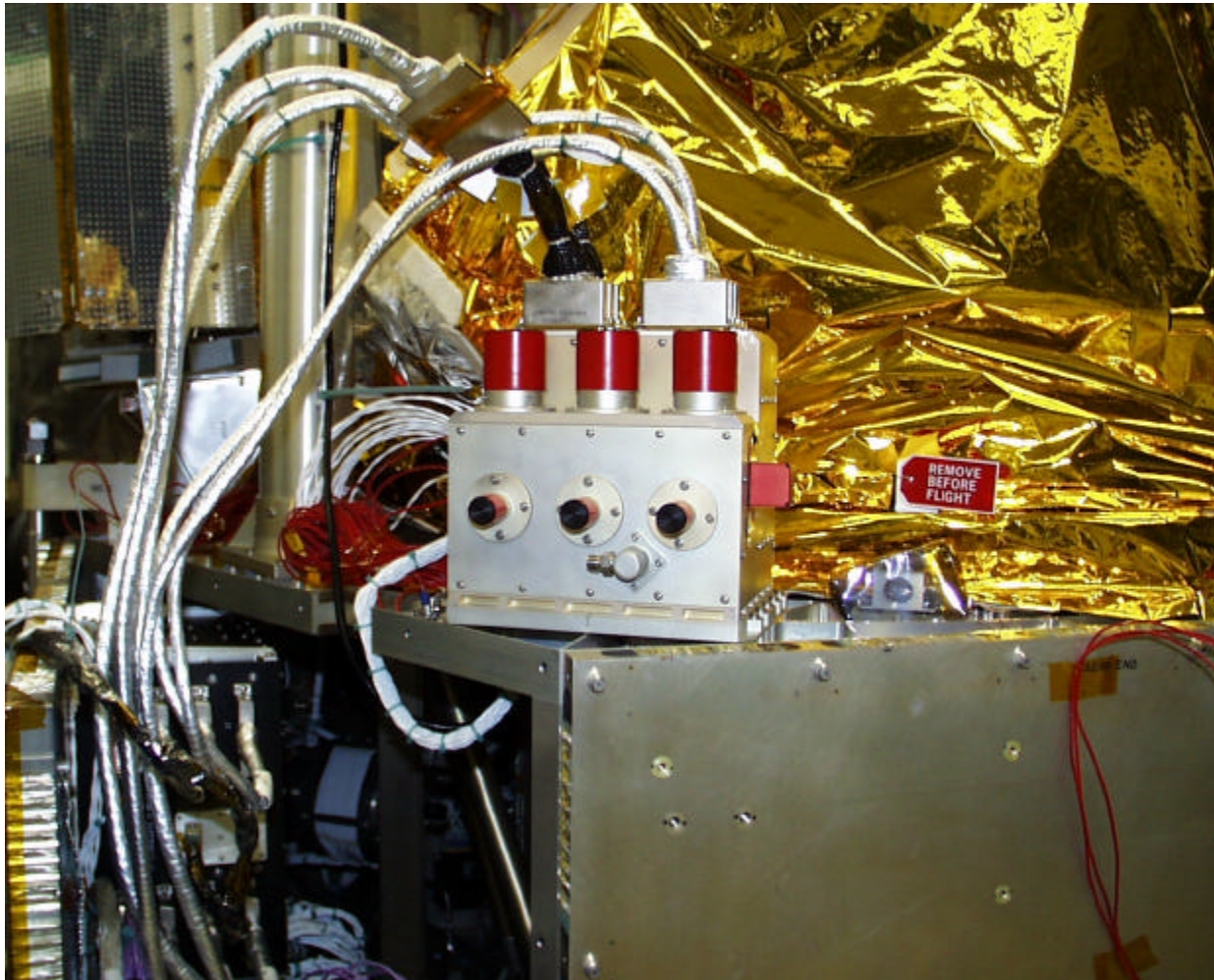


Data Flow

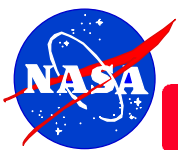




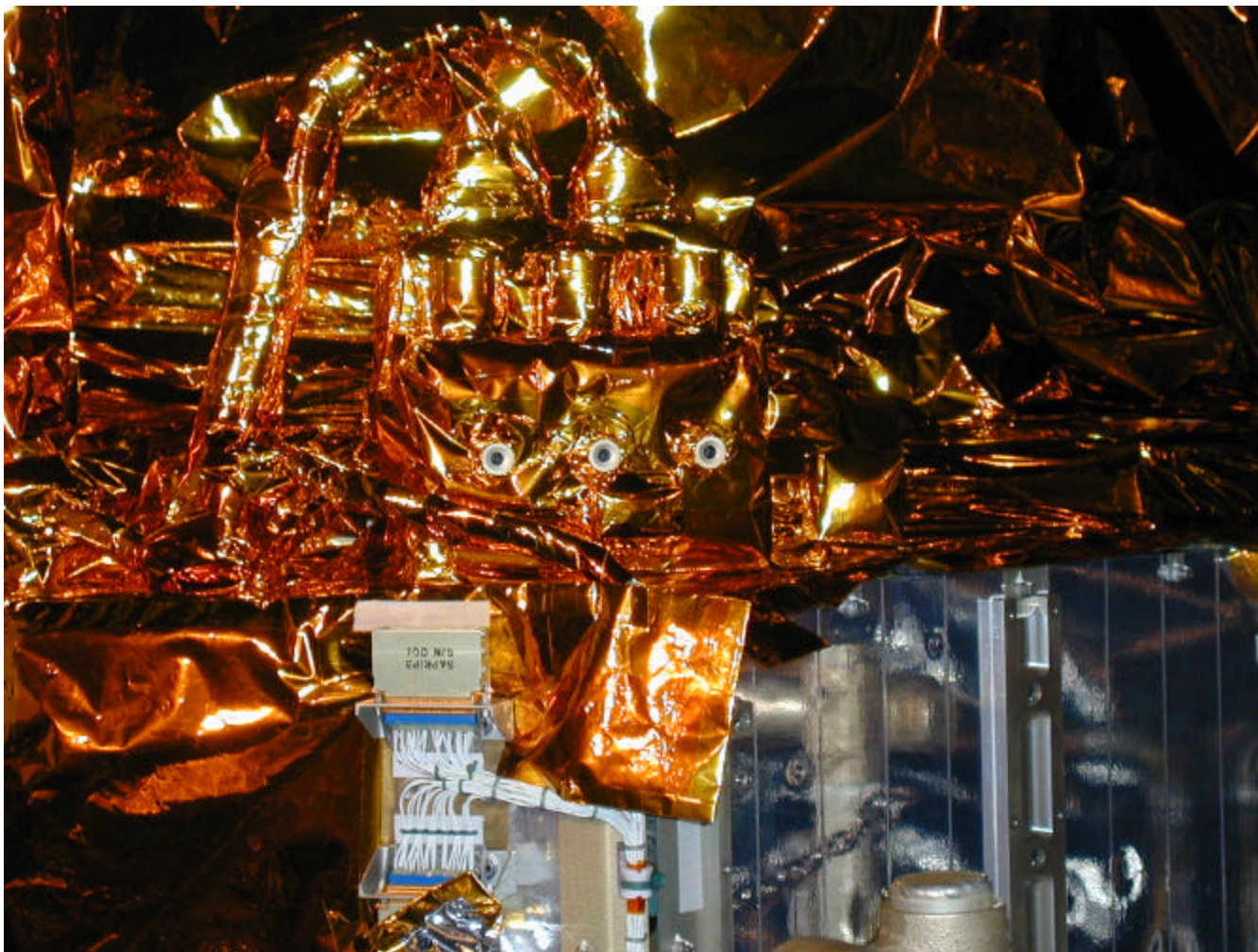
LAC on Spacecraft

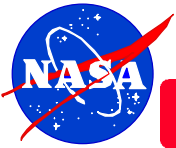


- ◆ *Atmospheric Corrector on EO-1*
- ◆ *Three lenses are nadir facing*
- ◆ *Solar Calibrators are facing forward*
- ◆ *Alignment cube on right*



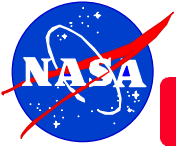
LAC Pre-Launch





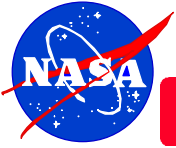
LAC Comparative Size



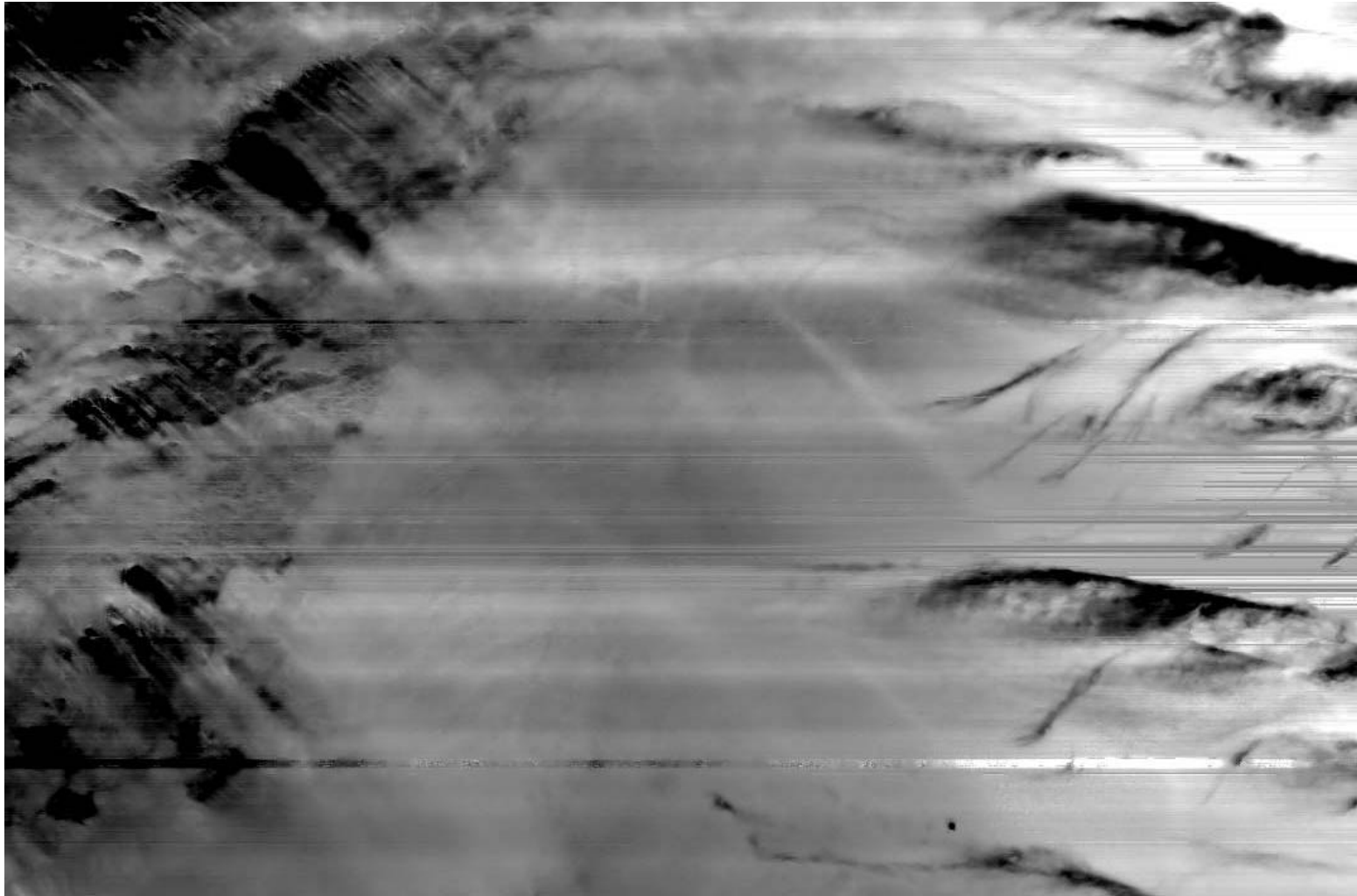


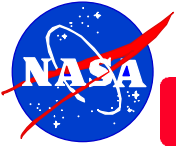
LAC Technology Transfer

- ◆ ***Compact design adaptable to many moderate Spatial Resolution Hyperspectral applications***
- ◆ ***Optics Module adaptable to redesign for differing spatial resolutions***
- ◆ ***Electronics Module adaptable to redesign for differing spacecraft interfaces***
- ◆ ***Spectral coverage/spectral resolution selectable by choice of Wedged Filter***
 - ***0.5 to 1.7 mm InGaAs Arrays Available***
- ◆ ***GSFC owns this design and is willing to infuse it into any U.S. commercial or academic institution***



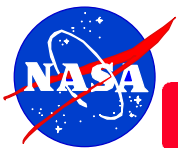
LAC Image of Niger3 (1.243 mm)



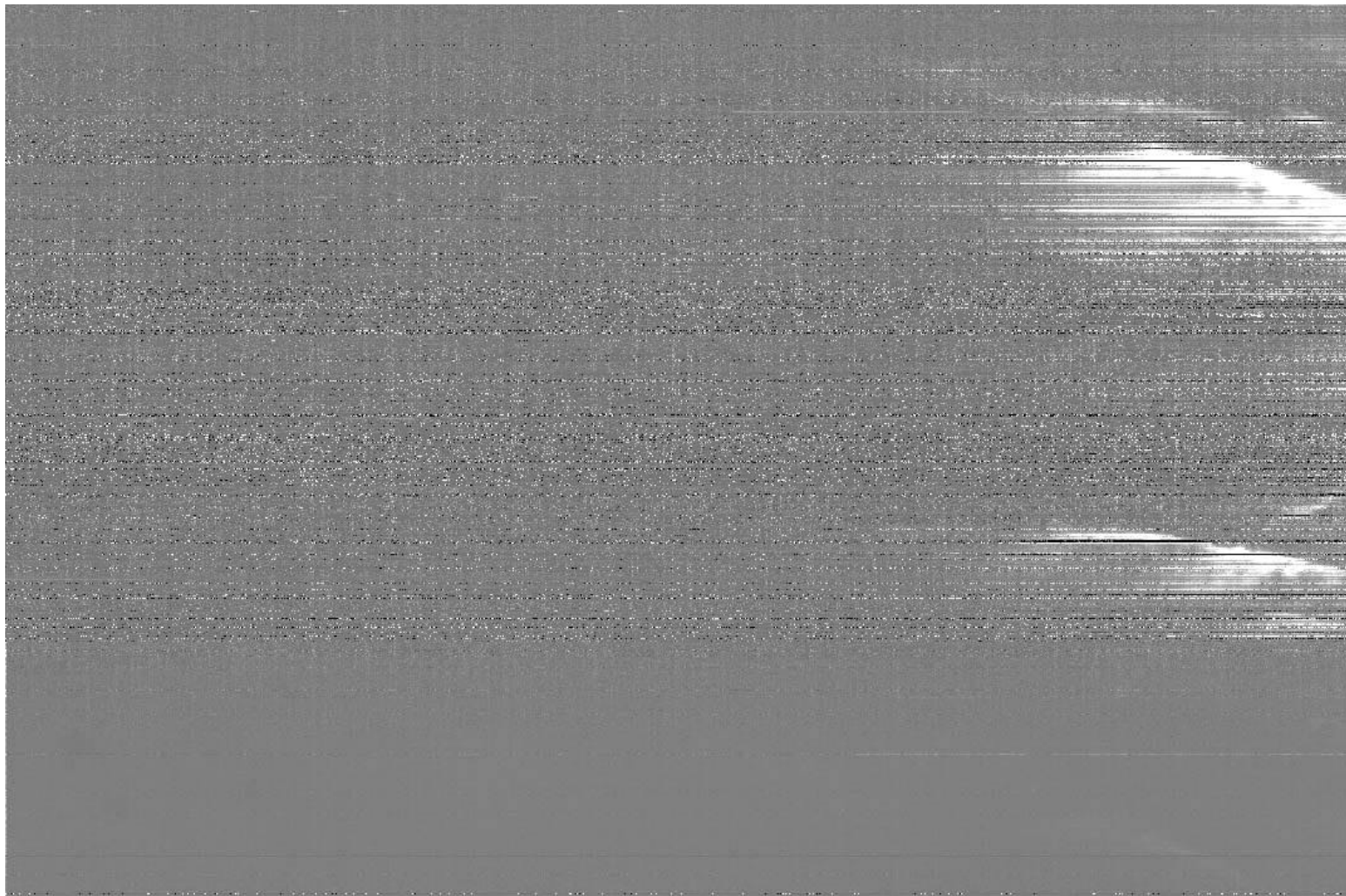


Landsat Image of Niger3



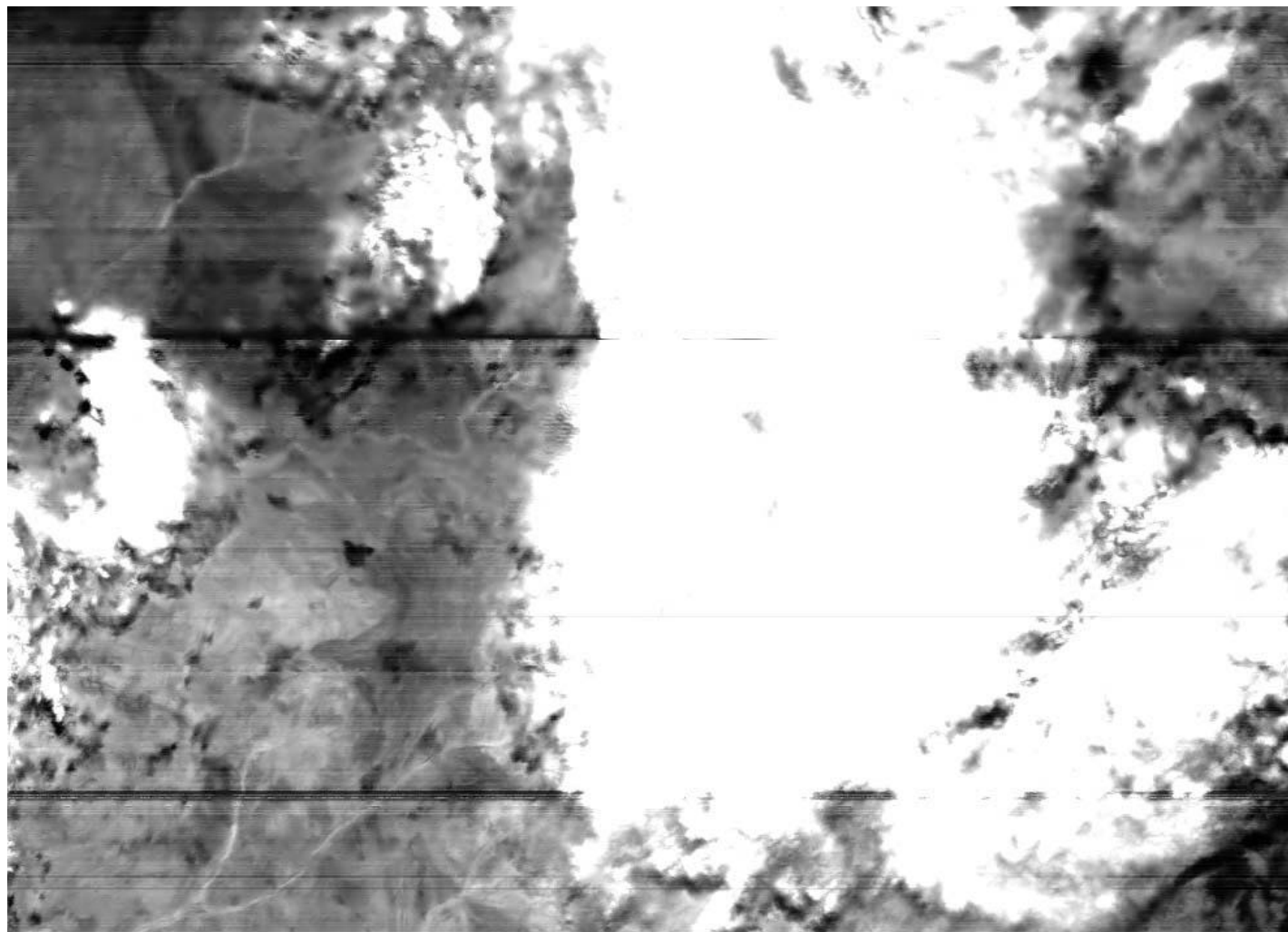


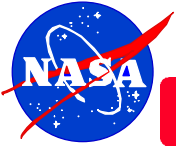
LAC Image of Niger3 (1.383 mm)





LAC Image of Panorama (1.243 mm)





Landsat Image of Panorama

